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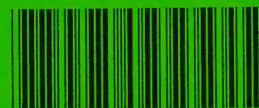
2000 SERIES
INDICATOR-RECORDER-CONTROLLER
and
3000 SERIES
INDICATOR-CONTROLLER

INSTRUCTION MANUAL

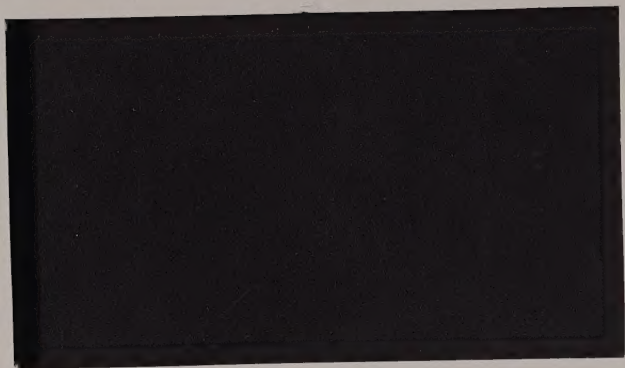
BARBER-COLMAN COMPANY

Industrial Instruments Div. • Rockford, Ill., U.S.A.

MP MASTER



MA32111



2000 SERIES
INDICATOR-RECORDER-CONTROLLER
and
3000 SERIES
INDICATOR-CONTROLLER

INTRODUCTION

This instruction manual has been designed to help you secure maximum benefits from the installation of your new 2000 Series Indicator-Recorder-Controller or 3000 Series Indicator-Controller. The 3000 Indicator-Controller uses the basic components of the 2000 Recorder-Controller with the exception of the recording feature. All data in this book is applicable to both models except where noted.

This manual should be given to persons responsible for installation, operation and maintenance of this instrument.

Your Barber-Colman factory trained field engineer is always available for further help in the solution of your control problems. Offices are located in all principle cities.

BARBER-COLMAN COMPANY
Industrial Instruments Division

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CIRCUIT DIAGRAMS

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SECTION I

DESCRIPTION

The Electronic Circuit

The Barber-Colman Recorder-Controller-Indicator is a continual null balance type d-c potentiometer. Electronic null balancing action is accomplished in the following manner:

The primary element senses an emf. This small d-c voltage generated by the thermocouple or other sources is measured and compared to a standard reference voltage. Reference voltage is from the CVS (constant voltage supply). If there is a difference in the two voltages, an unbalanced condition will exist. This d-c unbalance is converted to an a-c signal and amplified through a high gain amplifier.

The output of the amplifier is applied to a two phase balance motor which adjusts the position of the variable contact on the slidewire, increasing or decreasing the measuring circuit voltage to bring circuitry to an electronic null balance. The balance motor also drives the pointer along a calibrated scale to indicate the condition of the process variable.

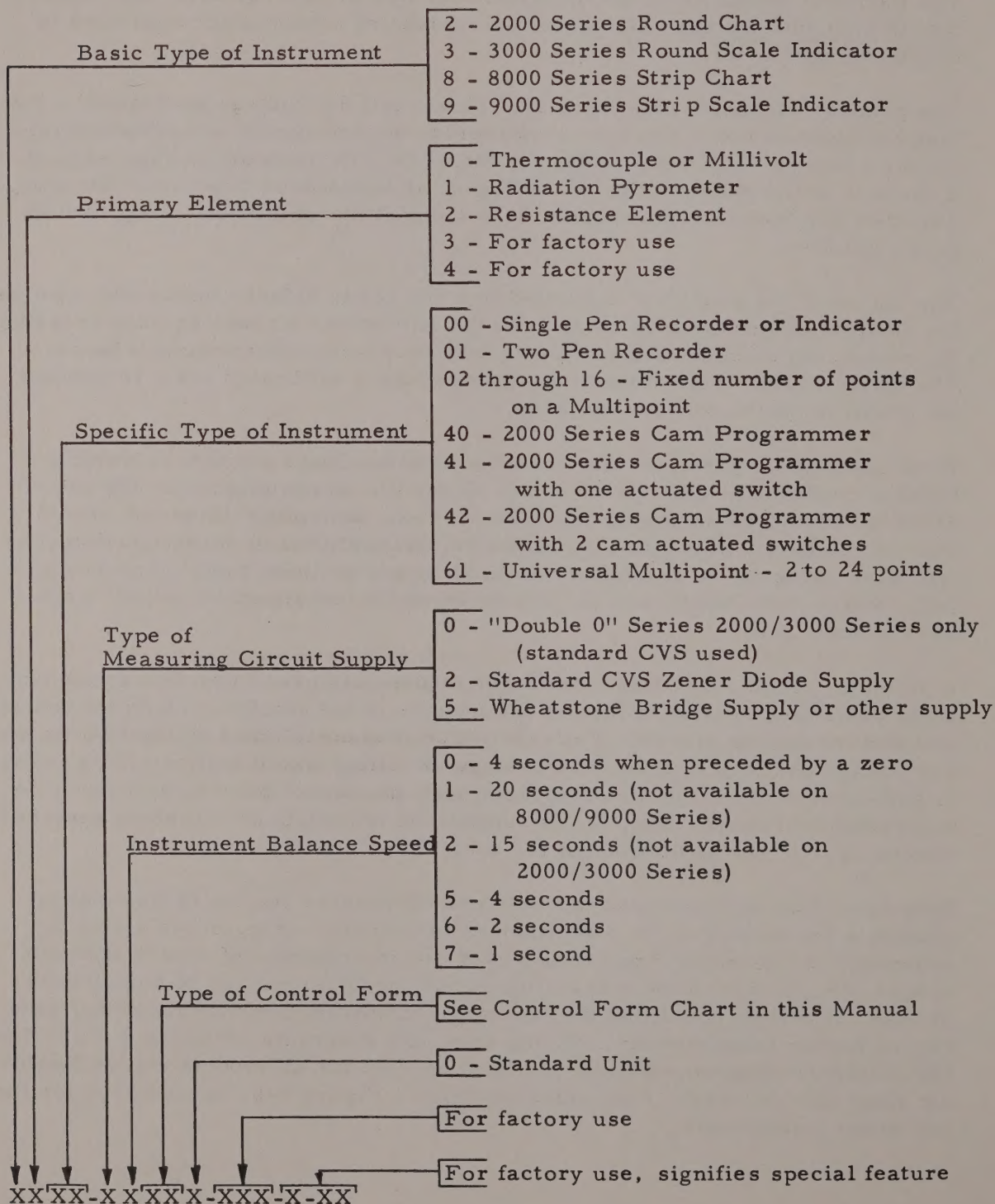
When used as a controller, the overall circuitry always strives to obtain a balance condition at the control point. Control is accomplished by the use of SPDT switches for two position, three position, and other forms of on-off control, or by a transmitting slidewire for proportional or three function control when using one of the Barber-Colman single or three function controllers (MC, MMC, MP, MMP, etc.). For high and/or low signal actuation, limit switches are used.

A failsafe circuit, standard with many models, is used to protect equipment being controlled against failure of components in the amplifier circuits, sensing unit and measuring circuit. Failsafe action is accomplished by introducing an a-c voltage to the grid of the fourth stage of voltage amplification. This voltage is sufficient to drive the motor upscale past the control point to shut down the controlled equipment. Failsafe is supplied with upscale drive unless specified otherwise. It may be eliminated for special applications.

Schematic diagrams included in the Circuit Diagrams Section of this manual illustrate the details of the potentiometric circuitry. Figure 5-1 shows the schematic of the measuring circuit used for instruments of over 3 millivolt range. Figure 5-2 is the measuring circuit used for ranges of 3 millivolts or less. It will be noted that the low range circuit is reversed from that used for the higher range models. Wiring assembly diagrams, Figures 5-7 and 5-8, and slidewire diagram, Figure 5-3, are correct for all models except they do not show this reversal. A shielded amplifier, Figure 5-6, is also used for the low range instruments.

The Model Numbering System

The Barber-Colman indicator or recorder model number is a five field 15 digit method of identification. This model number appears on the nameplate inside the recorder case. From this number the following information is provided:



Specifications

Indicating Scale	32" calibrated length Illuminated when specified
Chart	12" diameter, 4 5/8" calibration on 2000 Series only
Measuring Circuit	Potentiometric
Pen Speed and/or Indicator Speed	1, 4 and 20 seconds
Current Standardizer	Constant voltage standard
Sensitivity	1/10 of 1% for scale spans greater than 5 milli- volts. Five microvolts for scale spans of less than 5 millivolts
Scale Range	Available in full selection of standard scale ranges down to 1 millivolt full scale
Housing	Dust-proof steel construction with baked enamel finish. Molded phenolic door
Weight	Approximately 60 pounds
Electronic Failsafe	Standard with instruments having a span of 5 mv or greater
Accuracy	1/4 of 1% full scale range, 1/2 of 1% full scale range for 2000 "Double 0" Series
Control Switches	Adjustable over 100% of full scale range
Control Contact Rating	10 amps, 120 volts; 5 amps, 240 volts, non-inductive
Power Rating (2000 Series)	100 watts (96 v amp) with normal operation*
	NOTE: These ratings include fluorescent lamp
Power Rating (3000 Series)	90 watts (92 v amp) with normal operation*

SECTION II

INSTALLATION

Unpacking Instructions

This instrument has been carefully manufactured, inspected and packed at the Factory. Check contents against the packing slip. If the equipment is found to be damaged in transit, report extent of damage to the carrier immediately. Repack in original packing box until ready for installation. Any instructions given on tags attached to the instrument should be followed carefully and then removed.

CAUTION: Handle with care. Do not open main frame unless instrument is securely mounted or counter-balanced.

Mounting Instructions

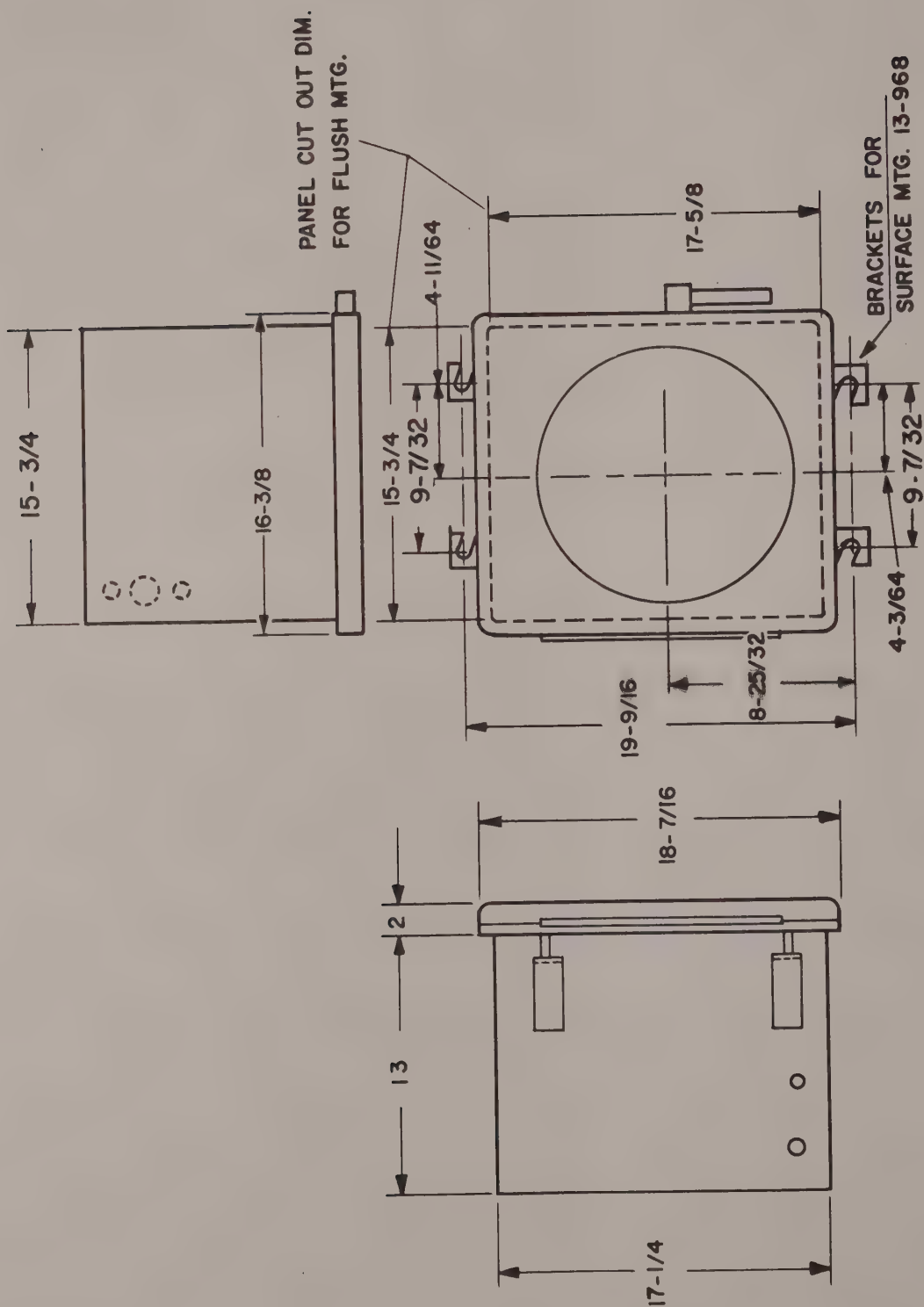
Locate the instrument to avoid shock, excessive vibration, dust or oil accumulations and moisture.

Avoid furnace walls, radiation of heat from furnace, oven frames and outside walls. Provide suitable shelter against moisture and temperature extremes if installed outdoors. Extreme ambient temperatures must be within the range of 32°F to 120°F. If lower temperatures are encountered, heaters must be supplied. Special provisions should be considered if the instrument is subjected to severe shock such as a drop forge or similar type of equipment. Vibration mountings are available when specified.

The instrument should be installed as far as possible from sources of external or stray electrical interference.

Instrument may be flush or surface mounted. See Figure 2-1 for mounting and panel cutout dimensions.

**PANEL CUT OUT DIM.
FOR FLUSH MTG.**



MOUNTING DIMENSIONS

Figure 2-1

Power Wiring

Check the rating plate on the inside of the housing for the supply voltage and frequency.

Connect proper voltage and frequency to terminals L1 and L2. Supply voltage should be 110 to 130 volts a-c. Voltages other than these require an additional transformer and should be specified on the order for the instrument. Run all wiring in rigid conduit, BX or Greenfield, in accordance with the recommended electrical code. Use properly fused switches.

Solid wire (14 gauge) is recommended for instrument wiring. If stranded wire is used, tin the ends to provide secure connections. Position the wires so that they do not interfere with amplifier chassis or the housing gaskets.

Unless otherwise specified, the instrument case should be grounded. When using an insulated panel, connections should be made to a grounded bus bar.

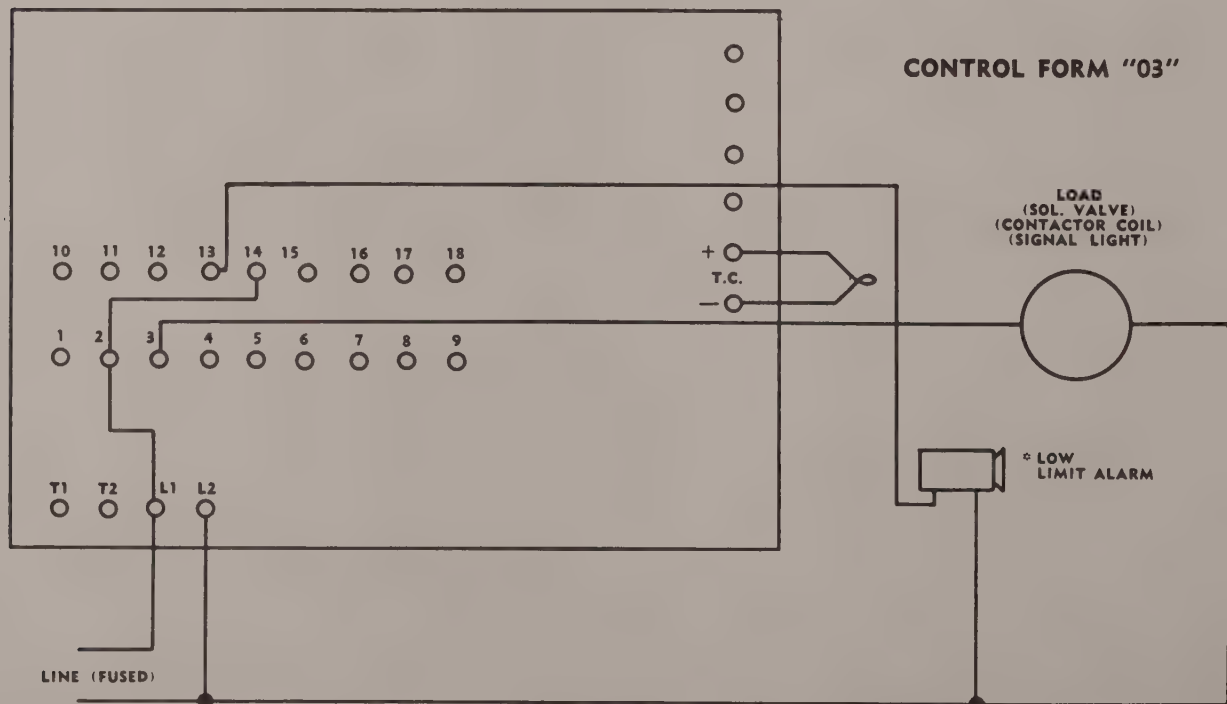
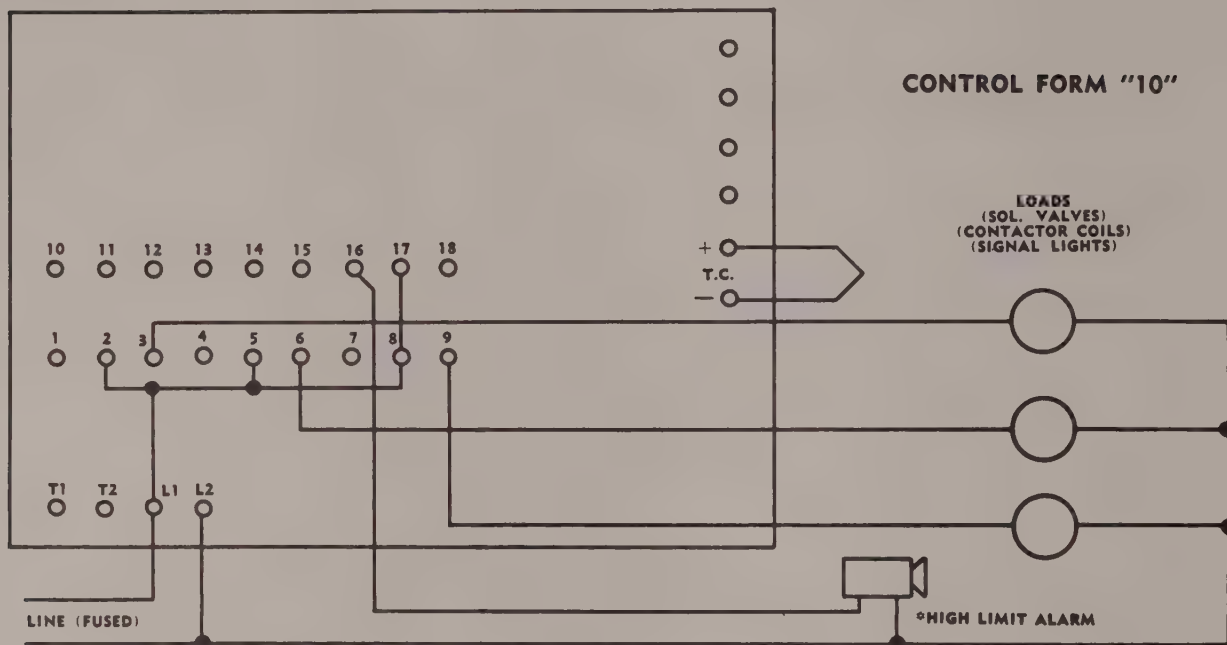
Thermocouple Wiring

Do not run thermocouple leadwire with other power or control wiring; however, several thermocouple leadwires may be run in the same conduit.

Proper polarity and the correct type of leadwire must be observed to obtain the correct reading. The negative wire is always coded red. Correct polarity of the leadwire can be checked by heating a temporary junction of the leadwire far end. Upscale drive of the instrument indicates the correct polarity.

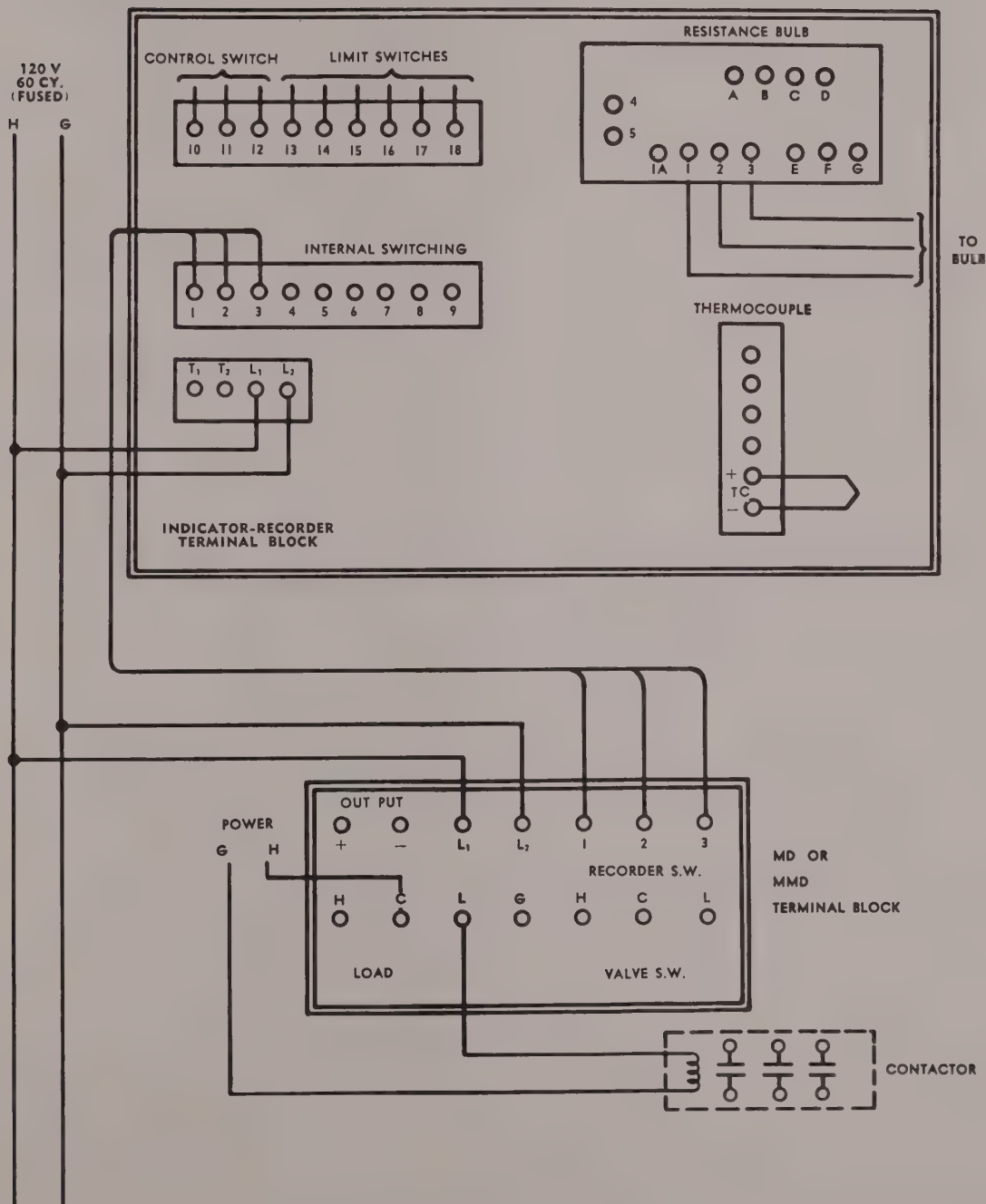
The thermocouple should then be connected to the leadwire and the indicating pointer should again drive upscale when the thermocouple hot junction is heated. If the indicator moves downscale, reverse only the connection at the thermocouple terminal head since the leadwire has already been correctly connected to the instrument.

**TYPICAL WIRING CONNECTIONS
(SWITCH TYPE CONTROL FORMS)**

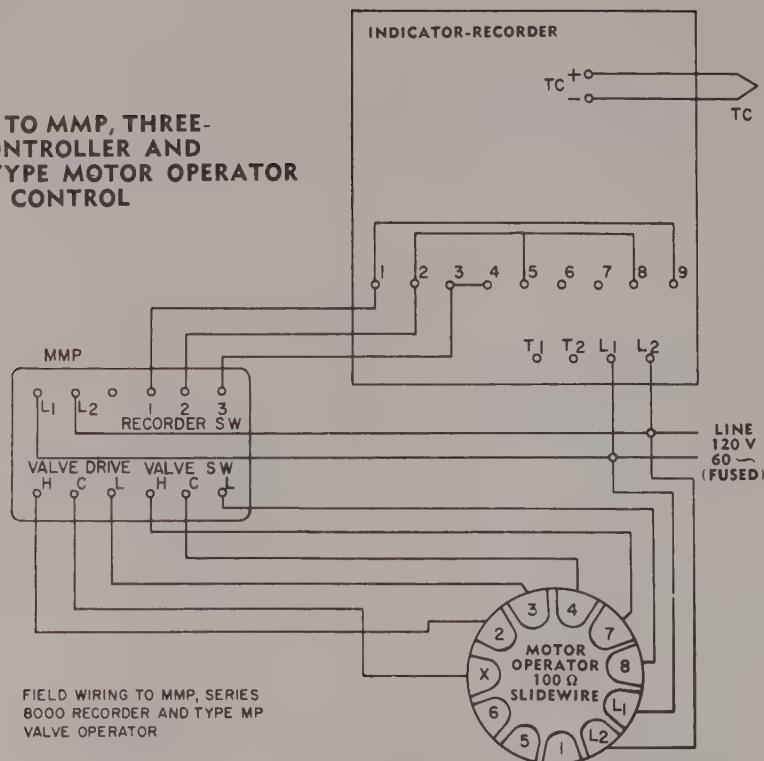


* NOT ADJUSTABLE WITH FRONT CONTROL KNOB
(INTERNALLY SETABLE)

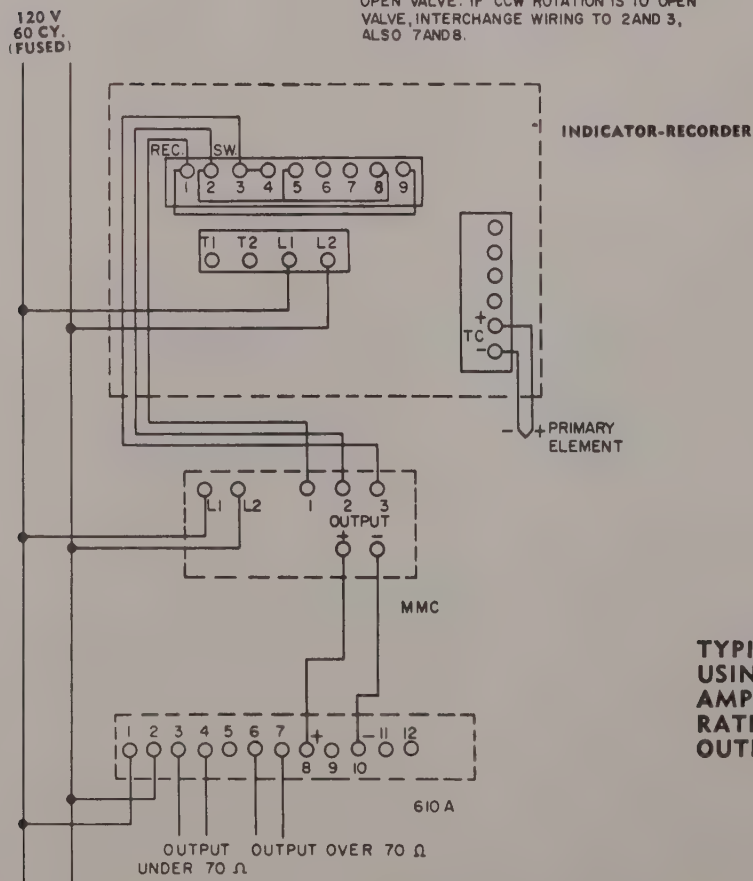
**External Wiring Connections from Model MMD
Magnetic Modulator for Duration Control of
Electrical Input Contactor.**



FIELD WIRING TO MMP, THREE-FUNCTION CONTROLLER AND INDUSTRIAL TYPE MOTOR OPERATOR FOR POSITION CONTROL



CONNECTIONS SHOWN ARE CW ROTATION TO OPEN VALVE. IF CCW ROTATION IS TO OPEN VALVE, INTERCHANGE WIRING TO 2 AND 3, ALSO 7 AND 8.



TYPICAL WIRING CONNECTIONS USING MMC AND PILOT AMPLIFIER FOR PROPORTION-RATE-RESET CONTROL OF OUTPUT CURRENT

SECTION III

OPERATION

Chart Installation

1. To remove the chart, perform the following:
 - a. Open recorder door.
 - b. Pull the pointer bracket outward and swing it away from chart.
 - c. Remove the chart edges from beneath the tabs.
 - d. Gently hold the pen and the red set pointer away from the chart face and slide the chart off the pointer spindle.
2. Chart installation is the reverse of removal.

Filling Ink Reservoir

1. Open recorder door.
2. Press latch spring and swing front frame outward. The ink reservoir is located on the right-hand back side of the front frame.
3. Remove reservoir cap and squeeze ink from supply bottle to fill reservoir. Replace reservoir cap.
4. Use syringe, furnished in the tool kit, to start the ink flowing through the supply tube. To do this, squeeze the syringe bulb, carefully insert the pen point in the small hole at the side of the rubber tip, and release bulb.
5. Included in the tool kit is a pen cleaner resembling a wire brush. If ink clogs, the pen cleaner wire can be inserted in the pen point to remove obstruction.

Control Switches and Limit Switches

The control and limit switches incorporated in the instrument are used to control, sound alarm, perform a predetermined function, etc., acting on devices external to the recorder.

The Barber-Colman instrument can have as many as six switches, consisting of four control switches and two limit switches. For diagram purposes, the control switches are numbered 1 through 4 with numbers 5 and 6 representing the two limit switches. See Figure 3-2.

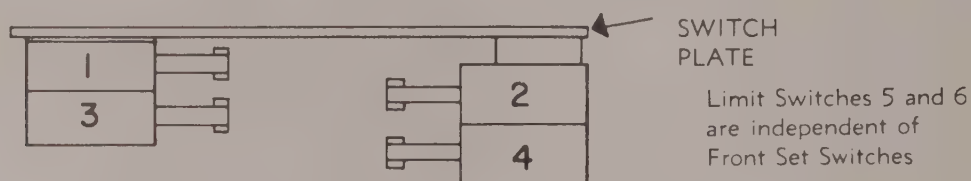


Figure 3-2

Front Set Control Switch Positions as Shown from Top

Control switches 1 through 4 are mounted on the switch plate. The switch plate is mechanically tied to the instrument red set pointer and will move whenever the set point knob (located on instrument door) is moved. The red set pointer and adjustable set point knob are supplied only with control forms 01 through 24.

Adjusting the switch actuating cams allows the control switches to be actuated at any point over the full instrument scale. Once the cams have been set to actuate the control switches at a desired point, their relationship with the red set pointer will remain the same. For example, if control switches 1 and 2 are supplied (control form 05), and control switch number 1 is set to actuate at 10% below the red set pointer and control switch number 2 is set to actuate at 20% above the red set pointer, the control switches will actuate at 10% below and 20% above the set point regardless of its setting.

Limit switches are independent of the control set point and are set to actuate at a fixed position on the scale. Although adjustable over 100% of scale range, they do not shift with position of set pointer. Control and limit switches are all rated at 10 amperes at 120 volts and 5 amperes at 240 volt, non-inductive.

Control Slidewire Action

For control forms 17 through 24, the leads from the 20% control slidewire are connected to recorder terminals 1, 2, and 3.

Referring to the diagrams below, it may be observed that control switches number 2 and 3 are used for the end limits of the 20% control slidewire. When the slidewire wiper is on the slidewire, both of the slidewire end limit switches (control switches number 2 and 3) are open (Figure 3-3).

As the slidewire wiper reaches the extreme high end of the slidewire (Figure 3-4) control switch number 3 closes and maintains contact between the slidewire wiper terminal 2 and the high end of the slidewire terminal 1. During this time the slidewire wiper is traveling across a non-conductive part of the control slidewire assembly.

The same type of action occurs when the slidewire wiper reaches and leaves the low end of the slidewire (Figure 3-5), except at this time control switch number 2 closes and contact is maintained at terminals 2 and 3.

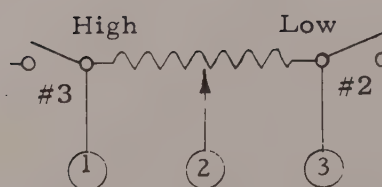


FIGURE 3-3

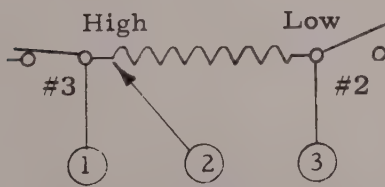


FIGURE 3-4

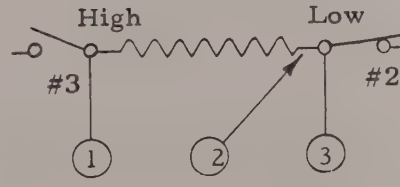


FIGURE 3-5

Control Forms

Control form variations available with this instrument are as shown in the table below. The number appearing in the sixth position of the model number identifies the control form number used for a particular instrument.

When instrument indicating pointer is below the point on the instrument scale where switch actuation is desired, the switch contacts will be in the position as shown. Encircled numbers are terminal numbers located inside the instrument case.

(x) indicates switches supplied with control form listed.

Control Form Numbers	Switch #1 	Switch #2 	Switch #3 	Switch #4 	Switch #5 	Switch #6
00	Indicator or Recorder only (no switches used)					
01	x					
02	x					x
03	x				x	
04	x				x	x
05	x	x				
06	x	x				x
07	x	x			x	x
08	x	x			x	x
09	x	x	x			
10	x	x	x			x
11	x	x	x		x	
12	x	x	x		x	x
13	x	x	x	x		
14	x	x	x	x		x
15	x	x	x	x	x	
16	x	x	x	x	x	x
17	See Note					
18						x
19					x	
20					x	x
21				x		
22				x		x
23				x	x	
24				x	x	x
29					x	
30						x
31					x	x

NOTE: For control form 17 through 24, a control slidewire (normally used in conjunction with the Barber-Colman M and MM Series Controllers) is connected to terminals 1, 2, and 3; therefore control switch #1 cannot be supplied. Also, control switches #2 and #3 are used for the control slidewire and are not to be used for any external control circuitry.

Setting Control Switches (if supplied)

Steps to follow using an ohmmeter:

NOTE: Power for the control switches comes from an external source and cannot be turned off by on-off switch in the instrument.

1. Turn off all instrument power switches.
2. Attach ohmmeter leads to appropriate terminals as shown on Control Circuit Diagram.
3. Loosen knurled nut on control shaft slightly, just enough to move control disc.
4. Move black indicator to desired control set point by turning the cross chart gear manually.
5. On the Series 2000 Recorder, set the red set pointer in coincidence with the pen by turning the control set point knob.
6. On the Series 3000, 8000, or 9000 Indicator-Recorders, place red indicator in coincidence with black indicator by turning the control set point knob.
7. Rotate control disc until control switch actuation causes zero deflection on ohmmeter.
8. Check this setting for make and break, making sure the red indicator and black indicator are at coincidence.
9. Hold control disc and tighten knurled nut firmly.
10. Recheck setting by moving temperature indicator above and below control point -- observing zero deflection on ohmmeter. Temperature control differential at set point will be determined by the differential of the control switch used.

NOTE: When setting control switches 2, 3, and 4, repeat steps 1 through 4 and 7 through 10. Control indicator (red pointer) should not be disturbed as #1 switch normally is used for main control setting.

If an ohmmeter is not available, listen to the switch make and break clicks which are normally audible. This method may be used effectively with the power on or off. An a-c voltmeter can be used when power is supplied to switches; however, electrical shock hazard to personnel is then present.

Limit Switch Adjustment

Using an ohmmeter, perform the following (see Figure 3-6):

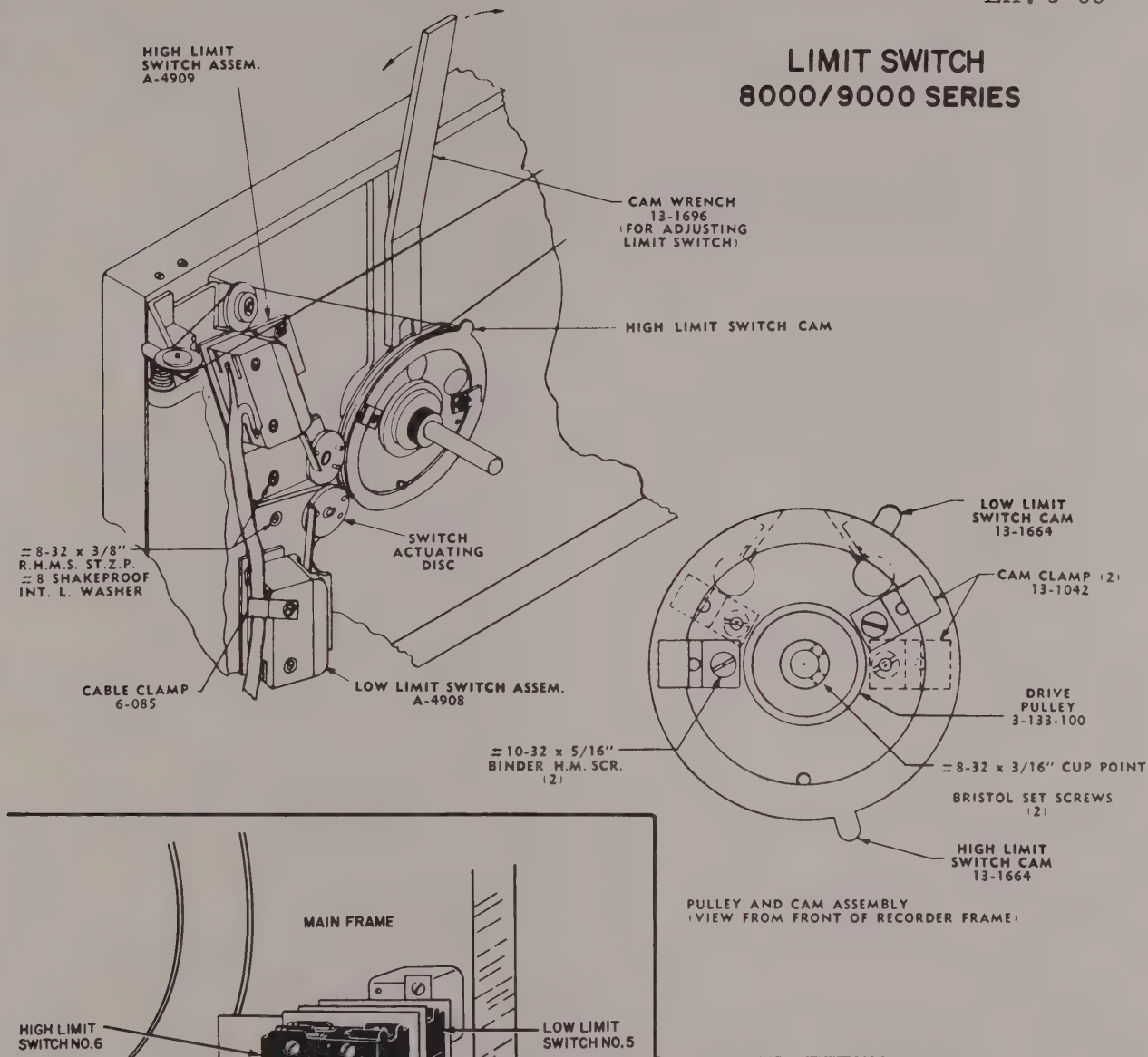
1. Turn off all power to the instrument.
2. Connect ohmmeter leads to terminals 16 and 17 (for high limit switch adjustment).
3. Turn main shaft so that the indicator is at the desired high limit.
4. While holding the main shaft at the desired setting, move the high limit cam lobe to actuate the switch at that point. No tools are required to make this adjustment on the Series 2000/3000 Indicator-Recorders. A cam wrench is supplied with the Series 8000/9000 Indicator-Recorders to adjust the limit switch cams (see Figure 3-6).
5. The exact point of switch actuation will be when the ohmmeter pointer drops from infinite to zero resistance, provided external circuitry is not wired to the instrument.
6. Move the indicator above the desired high limit setting. The ohmmeter reading should change.
7. Check the operation by connecting the ohmmeter leads to terminals 17 and 18. The action should be the reverse of the above.

NOTE: The low limit switch is set in the same manner using terminals 15, 14, and 13, respectively.

If an ohmmeter is not available, the switches can be set by listening to the click of the switch as it makes and breaks.

If lights or alarms are to be actuated by the limit switches, their on-off action must be used to determine the proper setting of the switches. Power must be applied, and caution must be observed since the switches carry line voltage. Power for the control switches comes from a separate source and cannot be turned off with the instrument on-off switch.

LIMIT SWITCH 8000/9000 SERIES



LIMIT SWITCH 2000/3000 SERIES

Figure 3-6

Changing Chart Speed

Standard chart speeds are 24 hour and 7 day. If desired, the speed may be changed one to the other by changing the chart drive motor and sprockets. Changing from the 24 hour speed to any of the special speeds listed below requires changing the motor only.

To change motor:

1. Remove two screws and two wire connector nuts.
2. Loosen set screw to remove male coupling section from shaft.
3. Install new motor of desired speed (order from Factory) and connect wires.
4. Replace chart with one whose calibrations correspond to new speed.

To change sprockets (necessary only when changing from or to the 7 day speed):

1. Remove chart plate.
2. Remove driver sprocket and shaft assembly by first removing two set screws from flex coupling shaft.
3. Install replacement sprocket and shaft assembly.
4. Remove driven sprocket and hub assembly by removing retaining ring.

NOTE: Do not attempt to force gear off the hub.

5. Install replacement sprocket and hub assembly.
6. Replace sprocket chain. Proper tension may be obtained by removing link or stretching, whichever is required.
7. Replace chart plate.

<u>Order Number of Motor</u>	<u>Motor Speed (per revolution)</u>	<u>Chart Speed (per revolution)</u>
35-186	5 min.	* 5 min.
35-187	15 min.	*15 min.
35-188	30 min.	*30 min.
35-189	1 hour	* 1 hour
35-190	8 hours	* 8 hours
35-191	1 day	* 1 day
35-192	2 days	** 1 week

*1/1 Ratio**1/3.5 Ratio

Driver Sprocket and Shaft Assembly

Order part numbers	A-3818	A-4000
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Driver Sprocket and Hub Assembly

Order part numbers	A-3828	A-4012
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Thermocouple Break Protection

Instruments equipped with thermocouple break protection (TCB) will safeguard the process and equipment in the event of a thermocouple open circuit. TCB adds a small voltage to the thermocouple circuit. If a break should occur in the thermocouple or leadwire, the added voltage will suddenly increase to drive the indicator pointer to the top of the scale (or bottom of scale if order for instrument is so designated), thereby shutting off power to the process.

Under some conditions this small voltage may produce a slight offset. Error can be calibrated out by rotating the recorder slidewire very slightly after loosening the three holding screws which attach it to the plate. Rotate the slidewire CW if the offset is on the high side, CCW if it is on the low side. Moving the pointer to compensate for error is not a good practice because this disturbs the relationship between pointer full scale travel and the setting of the slidewire stops.

Installing TCB:

The thermocouple break circuit consists essentially of a resistor of suitable size placed between the CVS terminal and the TC terminal. For troubleshooting TCB, the following table lists the range of resistors normally used and where they are located:

NOTE: TCB is not available when an emissivity potentiometer is supplied in the instrument for use with a radiation pyrometer.

Instrument Range	TCB Drive Direction	Ohms (1/2 watt)	Location
Above 5 mv	Upscale	27 k/100 k	Between TC- and CJ+
5 mv or below *	Upscale	27k/100 k	Between TC- and CVS-
Above 5 mv	Downscale	6.8 meg 2.2 meg	Between TC- and CVS+ Between CVS+ and CJ-
5 mv or below *	Downscale	68 k	Between TC- and CVS+

*Not recommended

NOTE: Polarities of CVS terminals are plus, minus, and ground, from top to bottom as viewed in place in the instrument.

Changing Instrument Range or Calibration

The range or calibration of the instrument may be changed in the field quite readily to any other calibration or range if above 5 millivolts. This is accomplished as follows:

1. Order new scale, chart and spool plate assembly. If thermocouple is also to be changed, order new cold junction card assembly. Specify range and calibration as shown in Replacement Parts List RL 1221.1.
2. Replace spool plate assembly. The spool plate is located in slidewire assembly and consists of three factory calibrated resistors and one carbon resistor, all mounted on one compact, easily removable mounting plate.
3. Replace cold junction card assembly, located on the CVS main plate. This is required only if type of thermocouple is changed, i.e, I/C to C/A, etc.
4. Replace indicating scale.
5. Replace chart.
6. Check calibration.

For ranges below 5 millivolts total span, consult your Barber-Colman field office if change is to be made.

SECTION IV

MAINTENANCE

While the instrument is well designed and manufactured of high grade components, it is necessary to have information for emergency servicing.

Where a number of instruments are located in the same area, many parts are interchangeable which allows a minimum of inventory.

The instrument man should familiarize himself with the instrument and its function in the operation of the process being recorded or controlled.

Service requirements can usually be traced to two basic problems:

1. Measurement
2. Control

The following sections can be used as a ready reference for maintenance details easily handled by a qualified service man. For assistance on service problems of a more technical nature, call your nearest Barber-Colman field office.

Quick Check List of Possible Troubles

Blown Fuses:

Check for short circuits in the following:

1. Lamp circuit
2. Chart drive and balance motors, or associated capacitors
3. Amplifiers

Pointer Drives Upscale:

Possible sources:

1. Open input element (TC)
2. Gain control too far counterclockwise
3. Defective V1-12AX7 (first and second voltage stage)
4. Defective V2-12AX7 (third stage, first section)
5. Open range spool
6. Slidewire contacts open circuited
7. Dirty slidewire

Pointer Drives Downscale:

Possible sources:

1. Reversal of TC leads. Check connections at TC head and TC+ and TC- posts in unit.

Sluggish Operation:

Possible sources:

1. Low amplification
 - a. Defective tube
 - b. Amplifier noise
2. Phasing capacitors defective
3. Gear train binding
4. Stray external signals

Balance Motor Fails to Operate:

Possible sources:

1. Input circuit open (no failsafe)
2. Amplifier defective
3. Measuring circuit open
4. Motor defective
5. Phasing capacitors defective
6. Stray external signals

Chart Drive Motor Fails to Operate:

Possible sources:

1. Defective motor
2. Defective phasing capacitor
3. Motor shaft and gear binding

Reads Ambient, Will Not Respond to Change in Input Signal:

Possible sources:

1. Shorted TC
2. Shorted measuring circuit capacitors

Balance Motor Operates but Pointer Fails to Drive Upscale or Downscale:

Possible sources:

1. Friction clutch slipping on main shaft
2. Broken cable
3. Screw on pen or pointer is loose

Chart Motor Operates but Chart Fails to Move:

Possible sources:

1. Broken ladder chain
2. Stripped gears either in chart drive assembly or loose main chart drive assembly.

Checking Calibration

Recorders are calibrated at the Factory to an accuracy of $1/4$ of 1% of full scale or better, with the exception of the 2000 "Double 0" Series which are calibrated to $1/2$ of 1%. This accuracy is to be expected, with no further checks, unless the instrument is damaged or range is changed. If accuracy of calibration is questioned, the following procedure should be used, provided the range of the instrument is such as to include normal ambient temperature.

1. Ascertain that the pointer spans the full range of scale. If it does not, loosen set screw on the indicator carriage and reposition on cable. On the 2000/3000 Series instruments, it will be necessary to loosen the set screw on the servo control gear and pinion to reposition the indicator.
2. Place a mercury thermometer inside case near cold junction to determine ambient temperature.
3. Disconnect TC+ and TC- and short the terminals.
4. Close instrument door and turn power on. Ample time should be allowed, with door closed and instrument running normally, to enable the cold junction spool to become saturated with case temperature. Drafts or opening of case door may cause errors during checking.
5. The pointer should read case temperature (ambient). If pointer does not indicate the correct temperature, proceed as follows:
 - a. Loosen the three slidewire assembly holding screws (see Figure 5-3).
 - b. Rotate the slidewire assembly until the pointer indicates correct temperature.

- c. Tighten the three holding screws.
- d. On the 2000 Series Recorders, it may be necessary to move the pen to correspond to the pointer setting. This can be done by loosening the pen's set screw, resetting the pen, and then tightening the set screw.

NOTE: If the instrument has a suppressed range, ambient temperature check cannot be made. For such instruments, the temperature at the low end of scale can be checked in the same manner as the high end, as described in steps 6 and 7.

- 6. Using portable potentiometer, perform the procedure outlined in instruction manual IN 1223-1, page 10, for top-of-scale calibration.
- 7. If pointer does not indicate correct temperature, proceed as follows:
 - a. Loosen slidewire assembly slider screw (see Figure 5-3).
 - b. If the reading is low, move the slider to the left; if reading is high, move slider to the right.
 - c. When correct temperature is attained, tighten slider screw.

NOTE: This setting is a Factory adjustment and should be done by a qualified service man.

Lubrication and Cleaning Instructions

Approximately once each month, apply oil as follows:

- 1. Using the special gear oil furnished (50-88) apply a small quantity to all cable pulley bearings and to gear teeth.
- 2. On multipoint models, place one or two drops of oil in oil tube of selector switch.
- 3. If instrument has a felt pad oil reservoir behind the cross chart gears, keep pad saturated with oil.
- 4. Remove excess oil.

Under normal operating conditions, with normal atmosphere ambient, selector switches (multipoint models) and slidewire can be used without lubrication.

Checking the Constant Voltage Source

If calibration adjustments do not correct for errors in reading and it is suspected that the constant voltage supply may be in error, make the following checks:

1. Connect the leads of a voltmeter to terminals 1 and 4 on the slidewire assembly (see Figure 5-3). The voltage reading should be approximately 1 volt.
2. If the voltage should read extremely high, it is probable that the fault lies in the bridge circuit and not in the CVS itself, in which case the bridge resistors should be checked for proper value.
3. A voltage reading slightly higher than the calculated value may be an indication of loose contacts on the CVS panel or at the range strip (R1, R2, R3).
4. Only after the above checks are made should it be concluded that the fault lies within the constant voltage supply. If this is the case, it is recommended that the CVS panel assembly be removed and returned to the Factory for repair. The accuracy of calibration of this device makes field servicing impractical.

Sensitivity Control

The sensitivity adjustment potentiometer is located on the top center of the amplifier. This potentiometer is coupled from the first voltage stage by means of a capacitor and a fixed resistor to the grid of the second voltage amplifier.

Factory setting is generally satisfactory until tube emission becomes low, at which time the amplifier will become sluggish. When the sensitivity (gain) control is fully clockwise and sluggish condition continues to exist, replace tubes 12AX7 and 5763.

Adjusting Sensitivity Control:

1. Adjust sensitivity potentiometer CW until indicator pointer starts to oscillate.
2. Rotate potentiometer CCW until indicator stops oscillating.
3. Adjust control shaft CW until motor torque is greatest without motor oscillation.

Suggested Replacement Parts

It is suggested that the following spare parts be carried by the user to insure against possible emergencies and accidental damage. These are listed in the order of probable relative need.

<u>Component</u>	<u>Quantity</u>	<u>Part Number</u>
Electronic Tube 12AX7	2	EYZP 70-10
Electronic Tube 5763	1	31-15
Electronic Tube 6X4	1	31-17
Fuse 1/2 amp)	Purchase locally	
Fuse 1 amp)		

NOTE: We recommend the purchase of 12AX7, 6X4 and 5763 tubes from the Industrial Instruments Division, Barber-Colman Company, to insure instrument functioning as designed.

Tools and accessories included with all potentiometer recorder-controllers are as follows (complete tool kit is listed as A-3566):

A-3464	Long dual bristol wrench with #6 and #8 keys
13-968	Surface mounting brackets
13-1034	Flush mounting brackets
13-1072	Open end wrench
13-1071	Open end wrench
13-1696	Limit switch adjusting wrench for use with 8000 Series models equipped with limit switch
50-88	Lubricating oil (Ucon oil) in plastic container - 3/4 ounce
A-1582	Wire pen cleaner)
A-3452	Pen filler) Single Point Recorders
56-07	Ink - for use with slow chart speed single point recorders
56-10	Ink - for use with fast chart speed and all 2000 Series Recorders
	Ink as specified for multipoint recorders

M A T E R I A L W A R R A N T Y

All equipment except tubes, photocells, and thermocouples, which within one year from date of shipment is found to have been originally defective, will be repaired (replaced if necessary) free of charge if returned prepaid to the Factory at Rockford, Illinois.

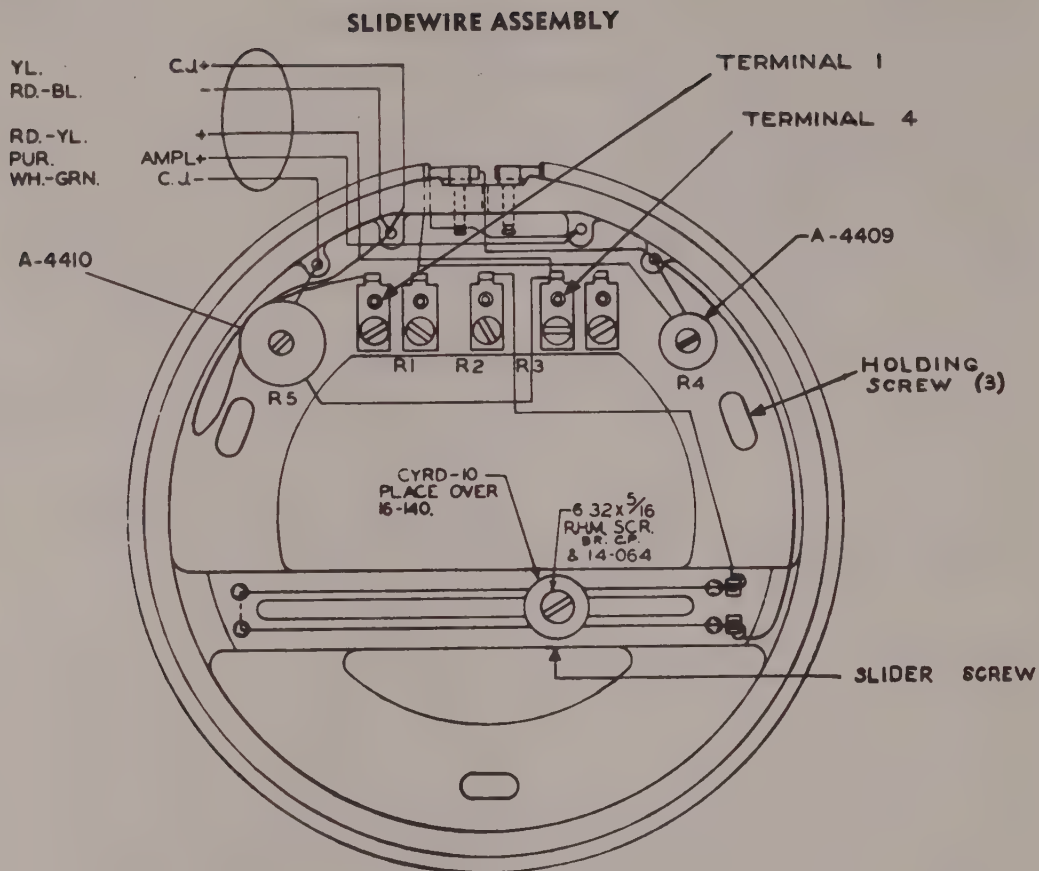


Figure 5-3

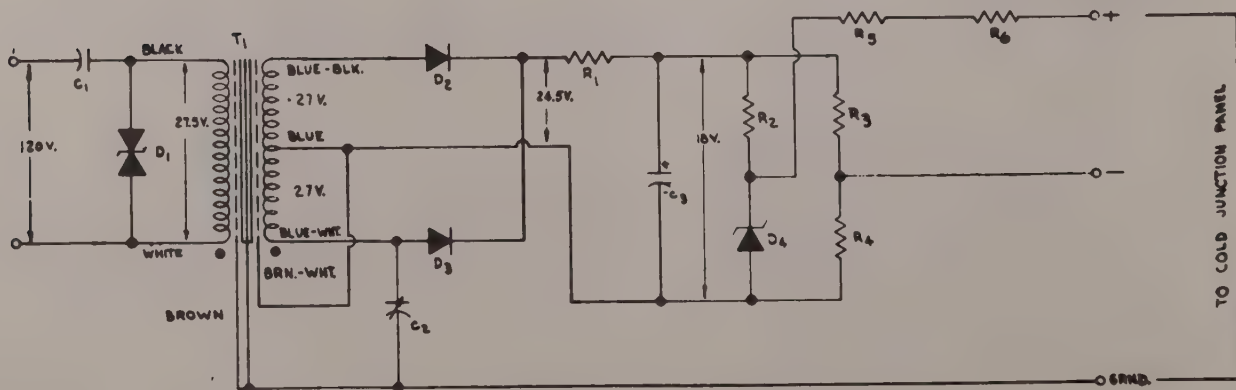
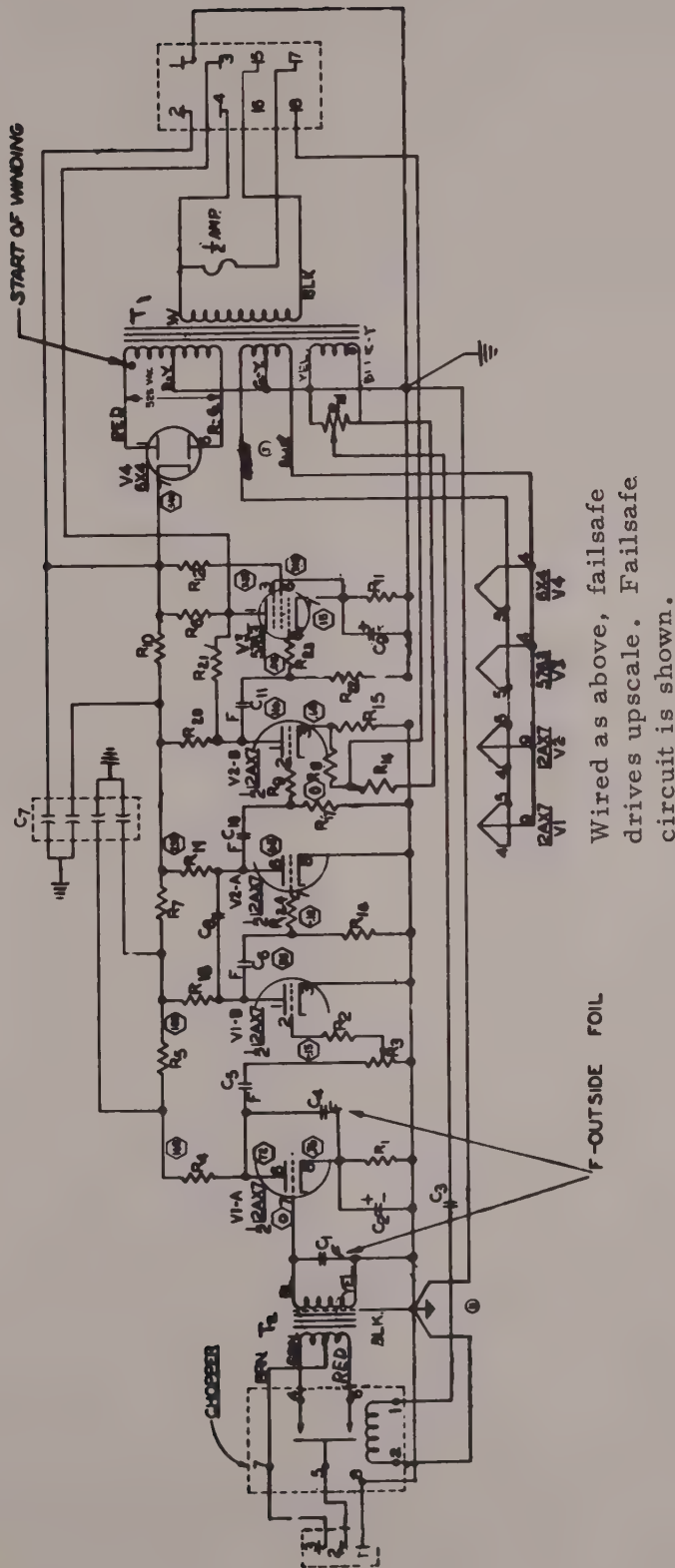
A-4628 CONSTANT VOLTAGE SOURCE WIRING SCHEMATIC

Figure 5-4

WIRING SCHEMATIC OF AMPLIFIER A-3373-1
USED FOR RANGES GREATER THAN 3 MILLIVOLTS

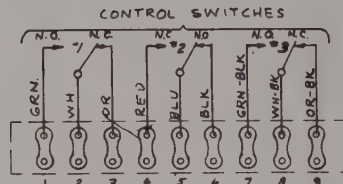
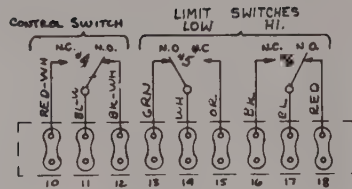


Wired as above, failsafe drives upscale. Failsafe circuit is shown.

NOTE: Failsafe not used below 5 mv.

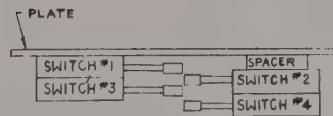
Figure 5-5

Internal Wiring Schematic 2000 Series Single Point Recorder (Range: Greater than 3MV)

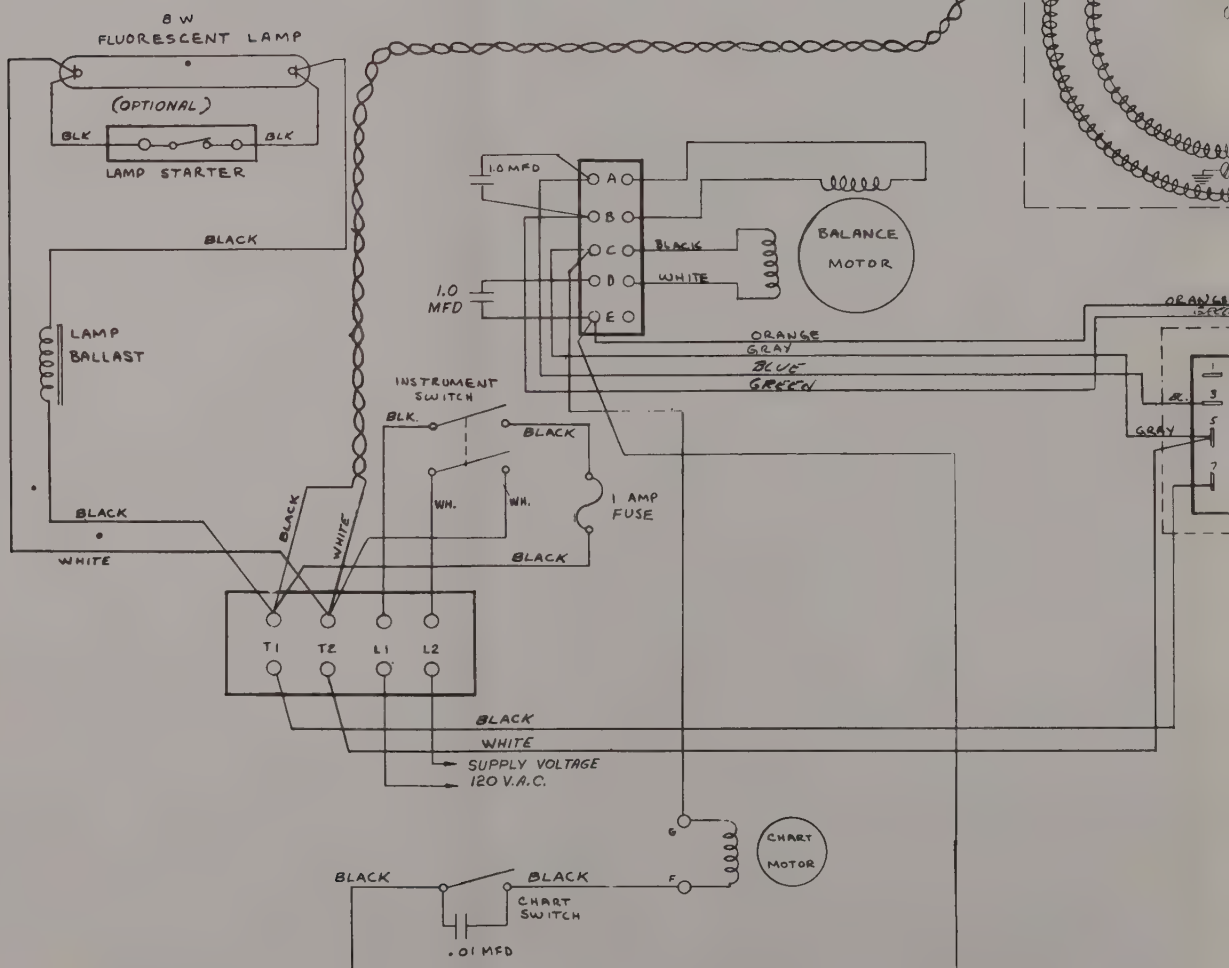


WIRING FOR 4 CONTROL SWITCHES
AND 2 LIMIT SWITCHES

SWITCHES SHOWN WITH INDICATOR
IN LOWEST POSITION BELOW SET POINT.



TOP VIEW FROM BACK SHOWING
LOCATION OF SWITCHES.



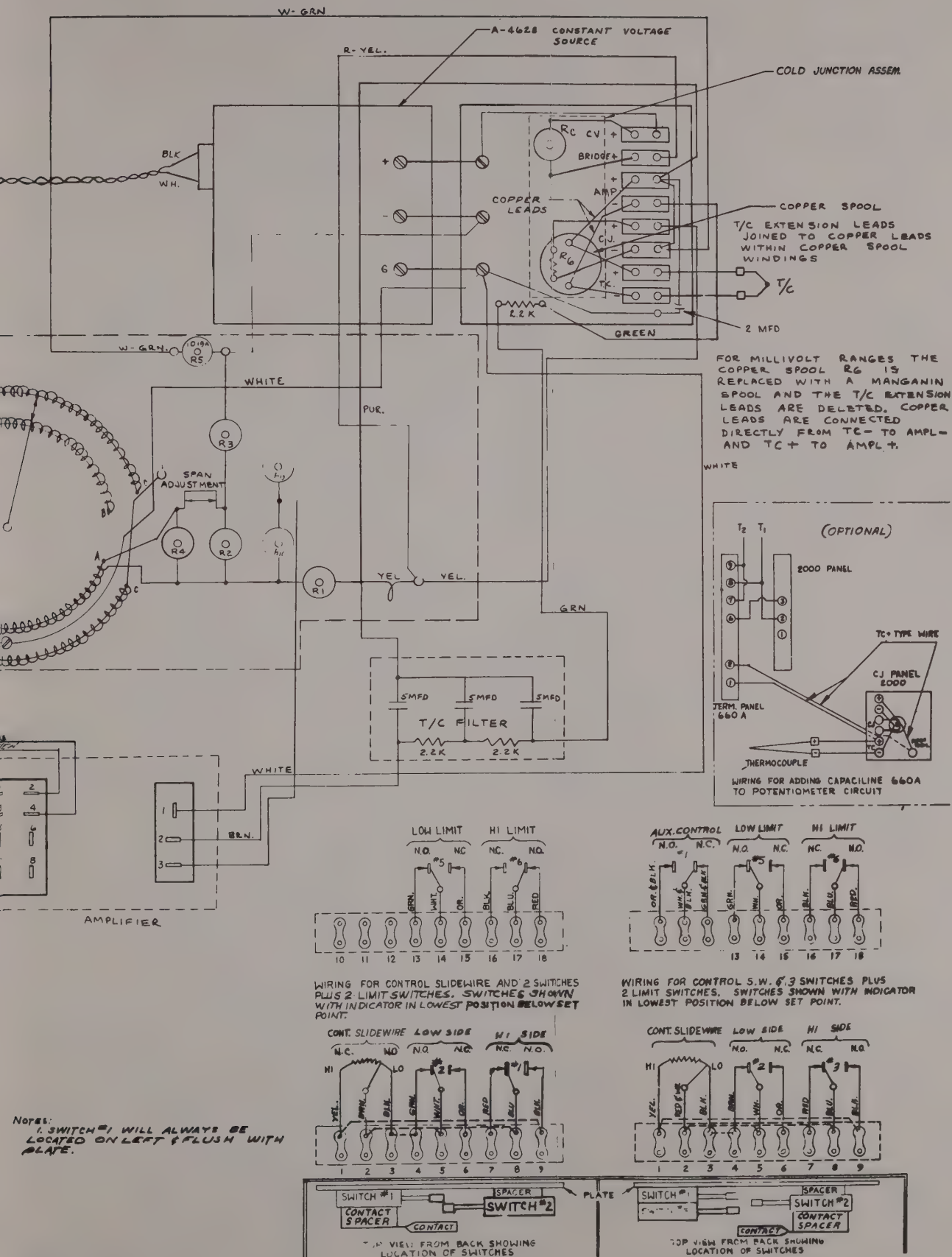
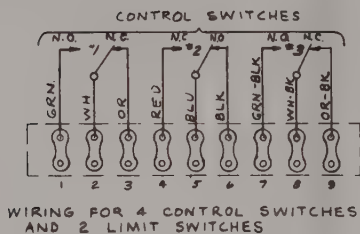
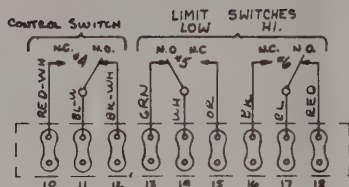
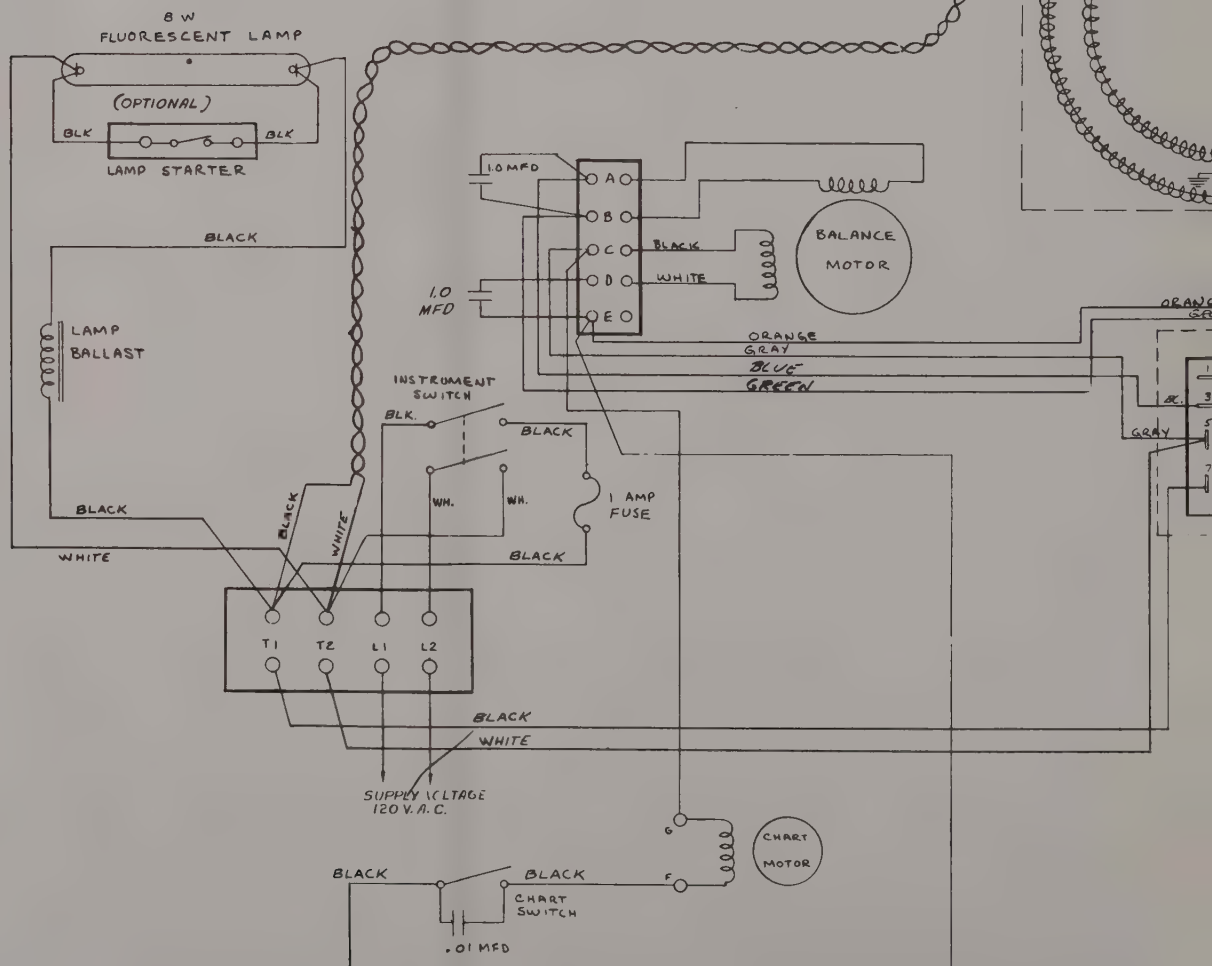
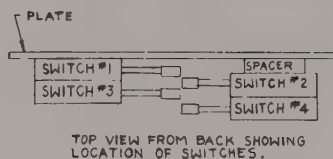


Figure 5-7

Internal Wiring Schematic 2000 Series Single Point Recorder (Range: Greater than 3MV)



SWITCHES SHOWN WITH INDICATOR
IN LOWEST POSITION BELOW SET POINT.



MP MASTER



MA32111